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Relationship between localized seismicity and lithospheric structure in a region of slow deformation (Alentejo, Portugal)

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Analysis of seismicity data together with detailed 3D velocity structure is widely used to reveal hidden active faults. But can these techniques be successfully applied to slowly deforming regions? Is there a relationship between concentrations of low magnitude seismicity, lithospheric velocity anomalies, and faults able to generate significant earthquakes?

We present a case study from Alentejo, Portugal, southwest Europe. Mainland Portugal lays on a stable continental region characterized by slow tectonic deformation rates (< 1 mm/yr). However, the region has been the source of moderate to large magnitude earthquakes in historical times. Remarkable seismic activity has also been recorded in the instrumental period. The crustal structure of mainland Portugal is segmented by major suture zones, which mark the boundaries between terranes of different provenances. Two major suture zones circumscribe the Alentejo region. It presents belts of high epicenter density and delimits a transition between a nearly aseismic area to the northeast and an area with significant seismic activity to the south. Inside the target area, the seismicity collapses into one well-defined lineation oriented NW-SE — the Arraiolos lineation, and one cluster presenting scattered epicenters — the Viana do Alentejo cluster.

Our objective is to identify unknown active structures that might have the potential to generate moderate magnitude events. In the absence of earthquake catalogues representative of the whole seismic cycle, we focus on the study of small earthquakes (ML < 4). We use a broadband temporary-array deployed in the area, as well as passive and active data acquired in the last decade to image the crustal structure. We present high-resolution images of the seismicity and lithosphere beneath the Alentejo region, namely: 1) newly detected earthquakes, which highlight the previously identified earthquake lineaments; 2) new focal mechanism solutions; 3) event relocations using the double differences technique; 4) cluster analysis based on waveform similarity and 5) 3D velocity structure obtained from the joint inversion of local and teleseismic earthquake travel times and active source data. We discuss the seismotectonic features of Alentejo region putting together our findings with the historical and instrumental seismicity.

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